

# Pavement System Preservation

## Fund 77

May, 16 2003

### SHA's Mission Statement

"To provide our customers with a safe, well-maintained and attractive highway system that offers mobility and supports Maryland's communities, economy and environment."

### Pavement System Preservation Mission

"To deliver a pavement system preservation program based on the most effective engineering design, considering the cost to the Administration, practicality of construction, and benefit in terms of service life and ride quality provided to the pavement network."

### Key Program Performance Goals:

- Improve the ride quality of SHA's pavement network.
- Improve the durability of the SHA's pavement network.

### Key Program Performance Objectives:

- Increase the percentage of pavements with an acceptable ride quality on the State Highway System from 82% to 86% by January 2005.\*
- Maintain annually 90% of pavements with an acceptable ride quality on the State Highway portion of the National Highway System.
- Increase the average service life of pavements on the Maryland State Highway System from 11 years to 12 years by January 2005.

\* For this document, the pavement system preservation goal was modified to 84% acceptable pavements from the original 86%. Based on previous shortfalls in the Fund 77 program the last few years, achieving our business plan goal of 86% pavement with an acceptable ride quality by January 2005 is not possible. The goal was modified to a challenging, but yet achievable goal of 84% in a future year.

### Key Program Performance Measures:

- Percentage of roads with an acceptable ride quality.
- Percentage of Maryland's National Highway System mileage with acceptable ride quality.
- Average service life of SHA pavements.

### Planning Process

Over the past five years MDSHA has considerably enhanced the pavement system preservation planning process. These enhancements have allowed MDSHA to evaluate various funding scenarios to preserve pavements today and in the future. The following section includes a brief description of this planning process. More details can be provided upon request.

### The Process

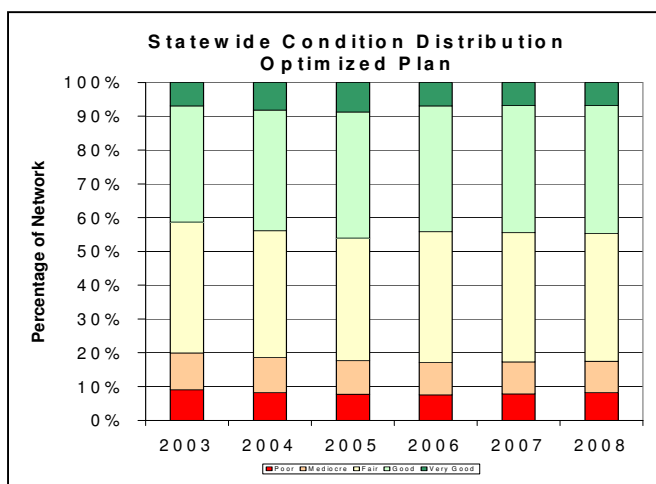
The pavement preservation planning process consists of four primary steps as follows:

1. Performance Monitoring
2. Funding Allocation Planning
3. Project Selection
4. Program Development

**Step 1: Performance Monitoring.** The condition of MD's pavement network is monitored annually using state-of-the-art testing equipment (10,000+ miles of testing). Pavements are monitored to evaluate the level of cracking, the quality of ride, the level of rutting and the degree of surface friction. In addition, completed construction activities are maintained in a statewide construction history database. A report is prepared annually from this data that documents pavement conditions and work accomplishments.

**Step 2: Funding Allocation Planning.** A network level optimization tool is used to identify the most beneficial allocation across the state of available pavement preservation funds. This tool

considers existing pavement conditions, repair costs, funding levels and budgetary constraints to arrive at a funding allocation plan. Pavement performance models have been developed that predict short and long term pavement condition consequences for various repair strategies and applications. The system is run under various funding levels and budgetary constraints for planning horizon, typically 20 years. Each run is compared by evaluating predicted network performance and funding distribution. A final plan is selected that meets performance objectives and that can be logically implemented. The performance objective is created based on **MDSHA Business Plan** which is to improve the percentage of acceptable roadways based on ride quality.



**Step 3: Project Selection.** The result of Step 2 in the planning process defines funding levels within each District and how the funding, within the District, should be spent. The selection of actual projects that will receive funding is conducted at the District level. The Districts are required to select projects consistent with the funding allocation plan. This is accomplished by setting goals for each District to achieve with their project selection program in terms of lane-miles addressed, costs and program benefit (benefit is based on future condition and disruptions to traffic). Projects are selected using an integrated software application that is housed in one location and is accessible across the state.

**Step 4: Program Development.** The candidate projects selected by the District are reviewed by a team led by the Chief Engineer. This team includes pavement, traffic and safety,

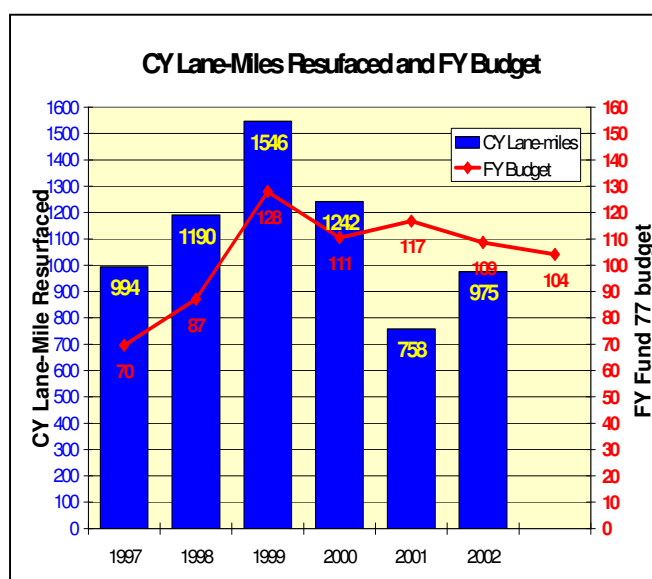
maintenance and design personnel. The team reviews the pavement preservation candidate projects with other system preservation candidate projects in a riding van tour. The tour is conducted to further prioritize and justify the need for project investments. After the tour is completed a Fund 77 program is established and is presented to the Administrator for funding approval. During the year modifications to the program could occur provided they still result in meeting the objectives of the approved funding allocation plan.

## Increasing Funding Needs

The following section identifies several reasons for increased funding levels for MDSHA's pavement system preservation needs. The benefits of the Fund 77 program are significant. The increased needs are due to higher investment requirements to maintain the health of the pavement network.

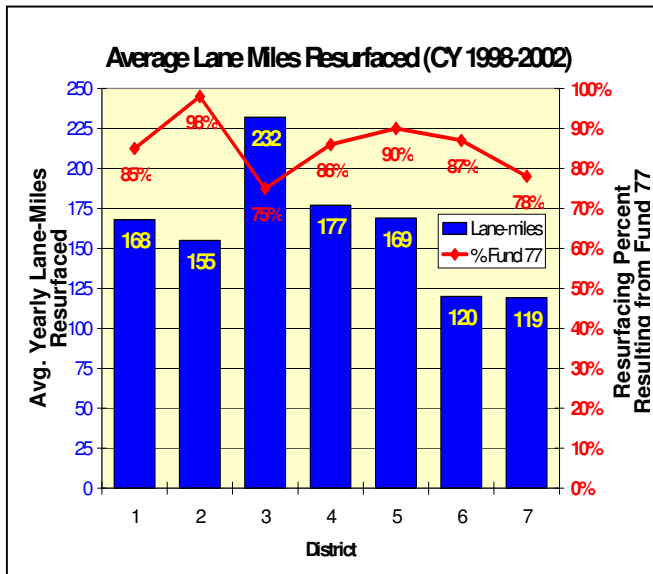
## Benefit of Fund 77 Program

Approved funding levels for the Fund 77 program have varied considerably over the past five fiscal years. Funding levels were their highest in FY 1999 at **\$128 million**. The funding level in FY '98 was at \$87 million and \$111 million, \$117 million, \$109 million and \$104 million in FY '00, FY '01, FY '02 and FY '03 respectively.



Over the **last 5 years** with these funding levels, MDSHA has averaged **1,148 lane miles** or 7% of the network in resurfacing each year with **85%** of those lane miles funded by the Fund 77 program.

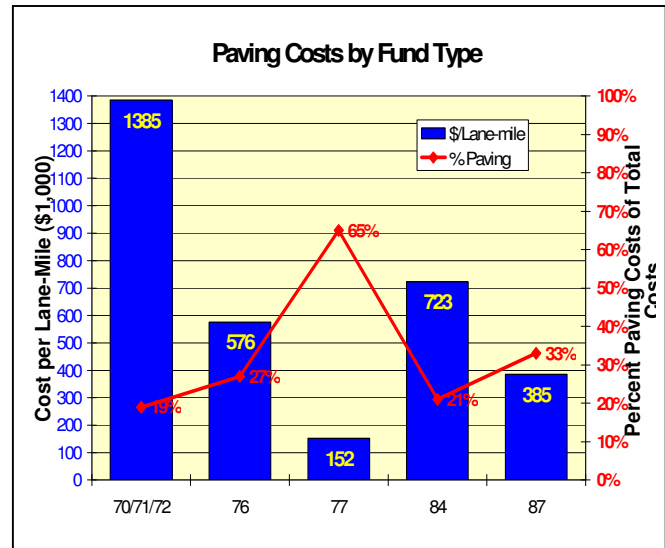
In **2002**, **975 lane-miles** were resurfaced with **83%** resulting directly from the **Fund 77 program**.



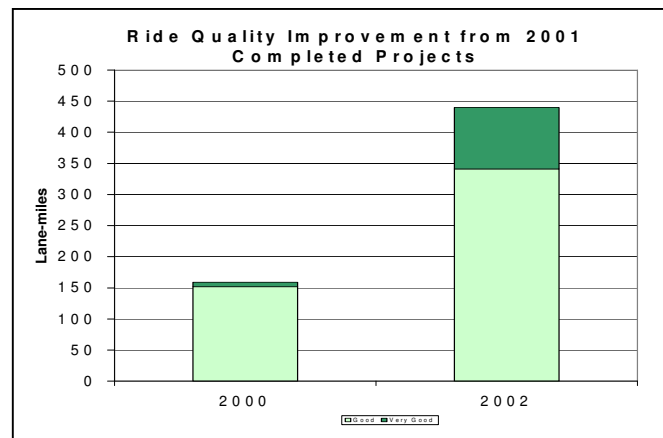
Any funding shortfall for the Fund 77 program will result in a reduced number of lane-miles resurfaced and have a significant detrimental impact on the overall condition of the pavement network. Any system preservation program that is not capable of addressing adequate lane-miles of the network will have impact on future years as pavements will continue to deteriorate further causing more costly improvements. This will result in a lower level of service as represented by pavement ride quality, rutting, cracking and pavement surface friction. After monitoring various MDSHA funds over the last 2 years through a cost database, several interesting trends have been identified. Based on this information, the Fund 77 program provides by far the most economical benefit to the MDSHA roadway network in terms of pavement improvement and system preservation.

The chart below shows that the projects in the Fund 77 program are at least three times more economical than other funding programs with regard to cost per lane-mile resurfaced. It costs MDSHA in contract bid items approximately **\$152,000 to resurface one lane-mile of roadway under the Fund 77 program** compared to \$1,385,000 under the Fund 70/71/72 program. Fund 77 also contributes the highest percentage of funding budget towards pavement related items compared to other funds. Approximately **65% of the money available under the Fund 77 program is utilized for pavement related items**

compared to 21% under Fund 84 and 27% under Fund 76. The costs shown in this chart are based on contract bid items and do not reflect the overhead or engineering costs related to the project.



Approximately 758 lane miles of the MDSHA network were resurfaced in 2001. Based on annual network level testing, only 159 lane-miles of those roadways were in good or very good condition in terms of ride quality before resurfacing. After resurfacing these roadways in 2001 with projects under the Fund 77 program, the **number of lanes miles in good or very good condition in terms of ride quality nearly tripled to 440 lane miles**.



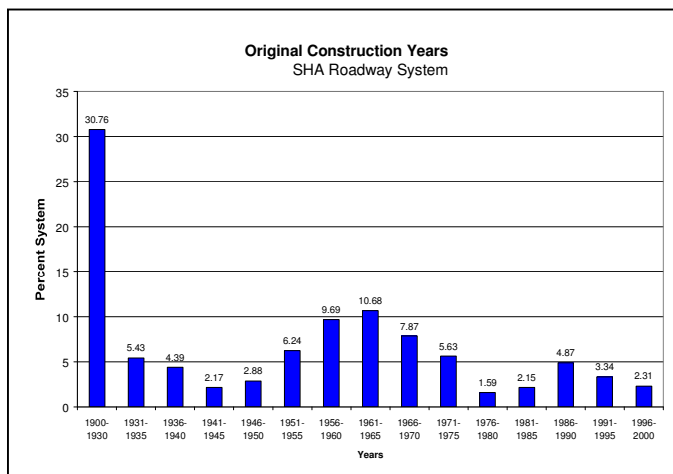
## Age of MD's Pavement System

The majority of MDSHA's pavement network is reaching an age that requires rehabilitation or reconstruction. As the network continues to age demands on system preservation will also increase. This is particularly true for pavements

constructed over 30 years ago. The following items address some of the issues related to MDSHA's aging network.

**Age of MD's Pavement Network.** MDSHA's pavement network is aging as the focus has moved from system expansion to system preservation.

- **31%** of MD's existing network was constructed prior to 1930.
- **40%** of MD's existing network was constructed between 1950 and 1975.
- **77%** of MD's existing Interstate network was constructed between 1950 and 1975.
- **80%** of MD's existing network includes pavements layers that are at least 30 years old.



These aging roadways require full depth repairs, substantial overlays, and in some cases total reconstruction. The current system preservation program is not large enough to fund these levels of repairs as a routine measure while still maintaining a healthy network.

**The Aging Interstate System.** MDSHA's Interstate system makes up about **16%** of Maryland's pavement network. The majority of these pavements were constructed over 30 years ago and require rehabilitation. Over the past four years and for the next few years MDSHA has and will focus attention on rehabilitating the Interstate system. This approach has required that about **1/3 of the Fund 77 program be dedicated to the Interstate system.**

## Composite Pavements

Composite pavements are older concrete pavements that have been overlaid with asphalt.

These pavements typically require full depth repairs that are in themselves not very costly but require expensive and disruptive maintenance of traffic operations. The following are a few facts related to MD's composite pavement network:

- 36% of MDSHA's pavement network is comprised of composite pavement.
- In MDSHA, 36% of the pavement network includes concrete pavements 30 years or older of which 23% has reached this age over the past 10 years.
- 18% of these older pavements are located on highways that include traffic volumes of 50,000 vehicles a day or more.

Major repair and rehabilitation of **composite pavements are more costly** than other types of pavements **because of maintenance of traffic demands and lane closure difficulties.**

Material costs in composite pavements are also more expensive compared to similar repairs on conventional flexible pavements. In fact, in some cases total reconstruction is the appropriate preservation decision. A list of roadway corridors that meet this criteria have been identified by MDSHA. The costs to replace or repair these older composite pavements over the next several decades could total well over \$1.5 billion.

It is important to note that the increasing costs to repair composite pavements is not due to the poor performance of concrete pavements. In fact, the contrary is more evident. In Maryland, concrete pavements have performed very well under very heavy traffic loadings with little to no maintenance and rehabilitation for up to 40 years after construction. The problem is that a high percentage of concrete pavements in MDSHA have been service much longer than their original design life. Concrete pavements will continue to be a viable option to construct and rehabilitate pavements in the future.

## Elimination of Neighborhood Conservation Projects

Neighborhood conservation and urban revitalization projects have different project goals objectives than Fund 77 and pavement preservation. However, the improvements made under neighborhood conservation and urban



revitalization program provided benefit to the MDSHA pavement network and system preservation. Through the efforts of our Pavement Management Section we have been able to estimate the benefit and contribution other funds make towards MDSHA pavement system preservation. **Approximately \$43 million per year from the neighborhood conservation and urban revitalization programs provide a direct benefit to the MDSHA pavement network condition**, based on the total budget for previous years funding levels. When funding for those programs was eliminated, it had a negative impact on the future pavement condition of the MDSHA network. The impact will be felt in the fact some of the neighborhood conservation and urban revitalization program projects not funded will still need to have the pavement condition improved under the Fund 77 program. Therefore, projects that were scheduled to be completed under Fund 77 program will need to be pushed out further into the future. The result will be more costly improvements and lowered pavement condition for the network as a whole. The result of higher improvement costs because roadways were not improved at an optimum time, will be fewer funds available to do other pavement preservation projects and a continuing deteriorating cycle for the MDSHA pavement network.

### Increase in Material Costs

From 1999 to 2000, the **costs of liquid asphalt increased 43%** from \$117/liquid-ton to \$168/liquid-ton. This increase has potentially reduced the number of lane-miles that can be addressed under the Fund 77 program by approximately **23%** based on this liquid asphalt price increase. The cost of liquid asphalt in 2001 went down to \$142/liquid-ton. In 2002, cost of liquid asphalt went back up to \$163/liquid-ton. **Currently** in May 2003, the price per liquid asphalt is at an all-time high of \$206/liquid-ton, which is a **76% increase in price since 1999**.

### Open Graded Friction Course

In the mid 1970's MDSHA began using an open graded friction course (OGFC or locally known as "popcorn") as a pavement wearing course on

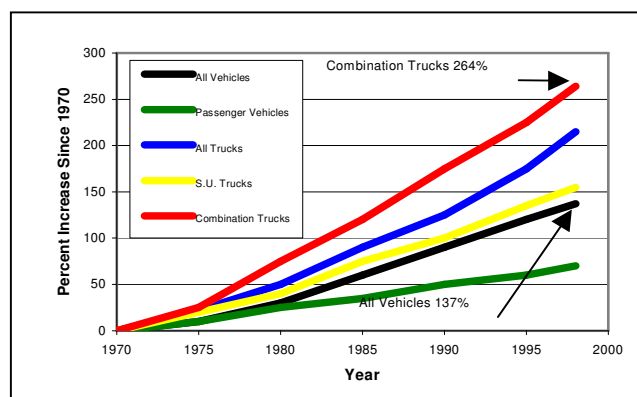
heavily traveled roadways. OGFC mixes were designed to improve skid resistance and the riding quality of the roadway. OGFC layers were placed as a thin lift and were designed to last about 8 years. The mix is porous in nature and when it ages it can ravel causing loss of aggregate particles.

Many of the OGFC pavements were reaching the end of their design life in the early 1990's. As a result, MDSHA invested a considerable effort in the 1990's under the Fund 77 program to remove or overlay these OGFC mixes as highlighted below:

- A total of approximately 2,365 lane miles of OGFC were placed on the MDSHA network. Over the past 10 years, **76%** or nearly 1,795 lane-miles of OGFC were removed or overlaid. Approximately, 570 lane-miles remain to be addressed.
- The effort to replace all of the remaining OGFC pavements would include some sections in good condition and be costly at approximately **\$87 million**.
- To address the most critical roadway section with OGFC pavements in mediocre and poor condition, a funding level of approximately **\$12 million** will be required.

### Increasing Traffic Volumes

Traffic volumes have increased substantially over the past 30 years requiring thicker pavements or overlays to support increased loadings. The following are facts that support this need based on both National and Maryland traffic data.



**Truck Volume Increases.** Traffic volumes as a whole have increased **137%** since 1970 and, in particular, tractor trailer volumes have increased **264%**. Over the past 15 years truck volume

increases have required a **63%** increase in funding to maintain and improve highway pavements.

**Truck Damage.** Although truck volumes make up only 10% to 20% of all traffic they contribute to approximately **90%** of the structural damage to pavements. Over the past two decades truck volumes have increased **three times faster** than passenger vehicles.

**Truck Weight** – Truck volumes have increased recently with the surge of SUVs in the auto industry which contribute very little to pavement damage. However, the damage to pavements due to heavier trucks has increased **58%** since 1998 which is still a substantial impact on pavement rehabilitation costs.

**Maryland Interstates** – The Maryland Interstate system has seen considerable traffic growth over the past decade. For example, the truck volume and weight increases on I-70 in Frederick from 1992 to 1999 has resulted in a **20% increase in pavement costs**.

Similarly, the damage due to truck loadings on I-95 between I-695 and I-495 has increased 60% over the past 15 years. As a result, **long term pavement needs on the Interstate system can not be met with current system preservation funding levels**.

## Predicted Conditions

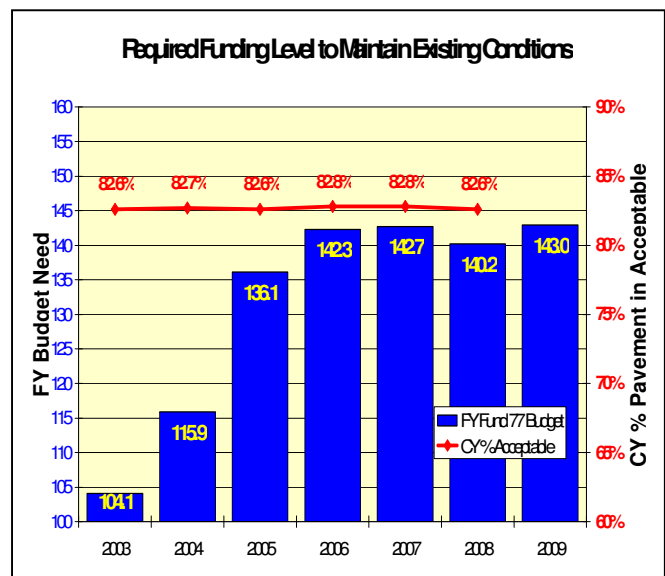
MDSHA's pavement management system was used to predict network level pavement conditions using programmed funding levels for the Fund 77 program. This analysis considered many of the factors discussed above such as a concentrated focus on MDSHA's Interstate system, the age of many of MDSHA's major highways, composite pavements, and the elimination of the benefit provided to the network pavement condition by the neighborhood conservation and urban revitalization programs. The optimization approach used by MDSHA in the Pavement Management System allows for the evaluation of literally millions of investment strategies over multiple years. As a result, the predictions from this system present the optimal condition possible given the budgetary and allocation constraints forced on the system.

Three approaches were used to identify the impact of the pavement network based on different Fund 77 budget scenarios. Those three options are as follows:

- The 5-year budget required for the Fund 77 program to maintain the MDSHA at its current pavement condition.
- The impact on the MDSHA pavement network condition based on the expected budget shortfalls in the Fund 77 program over the next 5-years.
- The 5-year budget required for the Fund 77 program to strive to meet the MDSHA Business Plan Goals for pavement system preservation.\*

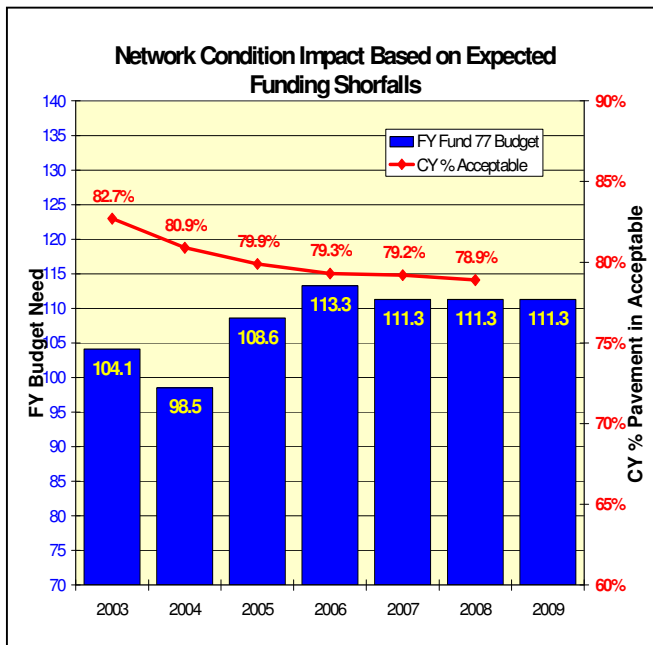
\* The pavement system preservation goal was modified to 84% acceptable pavements from the original 86% as discussed earlier.

The results of the first funding scenario option to maintain our existing pavement condition over the next 5-years is presented in the chart below. The results show that an **average of \$132 million** is needed over the next **5-years to maintain the existing condition of the MDSHA pavement network**.

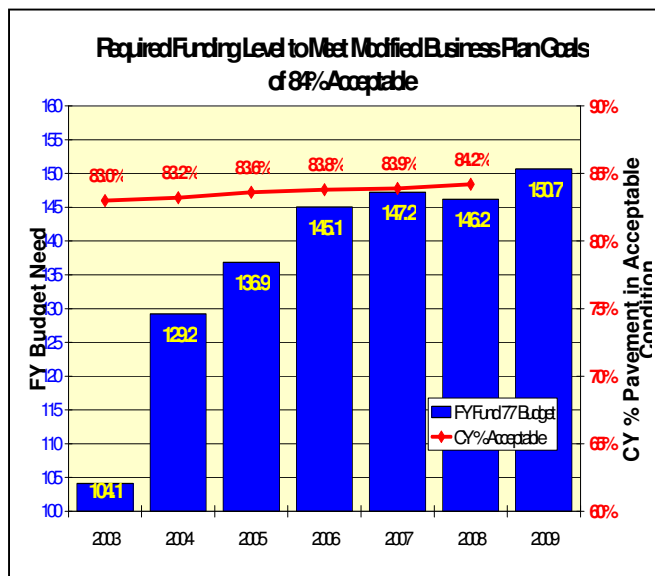


The results of the second funding scenario option are presented in the chart below. The second option was to review the impact on the MDSHA pavement network condition based on the expected budget shortfalls in the Fund 77 program over the next 5-years. The results show that with an **expected average of \$108 million** over the next **5-years** the MDSHA pavement network will **deteriorate and the percentage of**

pavements with acceptable ride quality will drop to less than 79%.



The results of the final funding scenario option are presented in the chart below. The final option was to review the Fund 77 budget needs over the next 5-years to meet a modified Business Plan goal of 84% acceptable pavements. The results show that an **average of \$137 million** is needed over the next 5-years to reach our modified Business Plan Goals of 84% of the pavements with acceptable ride quality.



The resulting budget funding gap to reach 84% acceptable pavements is **\$200 million** between FY 2004 and FY 2009.

## Funding Needs

The recommended funding levels to support the increasing pavement needs for the Fund 77 program are provided in the table below. **The figures in the table below are the funds required to only maintain our existing pavement condition over the next 5-years.** These funding levels have been compared to the future expected funds for comparison and calculation of funding gap.

Fiscal Year	Future Funding Level Needs for Fund 77 (\$ millions)		
	Approved Funding	Funding Need	Funding Gap
2003	\$104.1	\$104.1	\$0.0
2004	\$98.5	\$115.9	\$17.4
2005	\$108.6	\$136.1	\$27.5
2006	\$113.3	\$142.3	\$29.0
2007	\$111.3	\$142.7	\$31.4
2008	\$111.3	\$140.2	\$28.9
2009	\$111.3	\$142.95	\$31.65
<b>Total</b>	<b>\$758.4</b>	<b>\$924.3</b>	<b>\$165.9</b>

The funding and budget levels reported in this document are total budget dollars for the Fund 77 program. The total budget for Fund 77 includes construction costs, MDSHA overhead costs, engineering costs, operation and other costs. The construction and operation dollars fuel the resurfacing program improvements in MDSHA and provide the tangible benefits of pavement system preservation. The construction and operation dollars are typically \$15 to \$25 million less than the total budget levels shown in this document.